

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Provide all labor, materials and equipment to furnish and install all of the items specified herein, as necessary for the proper and complete performance of work and conformance with all applicable code requirements.
- B. This specification defines requirements that shall apply to prefabricated low voltage switchgear assemblies identified as Main Distribution Switchboards MDSB and Totalizing board. It defines the basic features of the equipment and the requirement that manufacturers shall fulfil in order to provide equipment manufactured and tested in accordance with International Electro-Technical Standards (IEC 61439-1 & 2).
- C. Refer to Division 26, Section “Diesel Engine Driven Generator Set” for the more details regarding the synchronization and paralleling features for the controls to be installed inside this switchboard, which will function as a totalizing panel.

1.2 GENERAL DESCRIPTION

- A. This specification relates to Low Voltage Main Distribution Switchboards (EMDSB) and Totalizing Board that will be manufactured according to the specifications defined in the IEC Standard: 61439-1&2: Factory- built with certified “Design Verification” by testing.
- B. Circuit breakers are to comply with EN/IEC60947-1&2 as specified.
- C. Other components, where not otherwise specified, are to comply with the relevant IEC standards.
- D. Panel builder shall submit calculation sheets for heat dissipation within enclosure verifying that adequate ventilation is provided (natural and not forced) with no de-rating of components inside enclosure. Enclosures to have suitable temperature control apparatus such as but not limited to anti-condensation heaters, hygostat required to keep internal temperature below 45°C.

1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
 - 1. ACB: Air Circuit Breaker.
 - 2. ACB NA: Switch Disconnect Air Circuit Breaker.
 - 3. MCCB: Molded Case Circuit Breaker.
 - 4. MCCB NA: Switch Disconnect Molded Case Circuit Breaker.
 - 5. LSIG or combination of these letters: type of protection and available adjustments on certain trip units.

- a. L: Long Time (overload protection, analogous to the inverse-time thermal trip of a thermal/magnetic breaker).
- b. S: Short Time (short circuit protection of low level faults).
- c. I: Instantaneous (short current protection of high-level faults, analogous to the instantaneous magnetic-trip of a thermal/magnetic breaker).
- d. G: Ground Fault (equipment ground fault protection).
- e. Therefore, LSIG = Long-time + Short-time + Instantaneous + Equipment Ground-fault Protection.

1.4 CODES AND STANDARDS

A. The following standards shall apply as a minimum:

- 1. IEC 61439-1/2: Low voltage switchgear & controlgear assemblies – Part 2 Power switchgear and controlgear assemblies.
- 2. IEC 61641-v2: Enclosed low voltage switchgear and controlgear assemblies Guide for testing under conditions of arcing due to internal fault.
- 3. IEC 60044-1: Current transformers.
- 4. IEC 60186: Voltage transformers.
- 5. IEC 60529: Degrees of protection provided by enclosures.
- 6. IEC 60664-1: Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests.
- 7. IEC 61000-4-1: Electromagnetic compatibility (EMC) Testing and measurement techniques.
- 8. IEC 61557-12: Combined performance measuring and monitoring devices for electrical parameters
- 9. IEC 60947-1: Low voltage switchgear & controlgear – part 1 General Rules.
- 10. IEC 60947-2: Low voltage switchgear & controlgear – part 2 Circuit breakers.
- 11. IEC 60947-3: Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units.
- 12. IEC 60068: Environmental testing.
- 13. IEC 61140: Protection against electric shock – Common aspects for installation and equipment – Basic safety publication.
- 14. IEC 60947-4-1: Low-voltage switchgear and controlgear - Contactors and motor starters.
- 15. Other components where not specified shall comply with the relevant IEC standards.

1.5 SUBMITTALS

A. General:

- 1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
- 2. Submit compliance sheet point by point and not by paragraph. Compliance must be highlighted/cross referenced to the page and paragraph in the catalog or data sheets for each item in the submittal.

3. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation. Any deviation not clearly submitted for approval by the Contractor will be rejected even after execution.
4. Submit heat dissipation calculation note relative to proposed design in order to insure that the temperature will not exceed the maximum allowed values of components without de-rating. The calculation note should be made taking into consideration the maximum current on the bus bars and should include all the MDB components (breakers, contactors, bus bars, incoming and outgoing cables).
5. Submit required product data and shop drawings specific to each product and accessory proposed. In addition, include the following information, including dimensions and manufacturer's technical data on features, performance, ratings and finishes.
6. Shop drawing file for each panel should include the following pages:
 - a. Header page giving all the details of the panel-board such as but not limited to: Panel rating and Short-circuit ratings of bus-bars and functional units, Horizontal and vertical bus capacities, dimension of the panel, entry of cables, IP etc.
 - b. List of components/material used
 - c. Front view with door closed
 - d. Front view with door opened showing the mounting of all the components
 - e. Bus-bars mounting view with manufacturer chart justifying the selection
 - f. Incoming and outgoing cables arrangement, terminal fittings and busbars connections
 - g. Power diagram with all the electrical characteristics
 - h. Control diagrams
 - i. Plans and elevation and exact dimensions and weights
 - j. Arrangement of the board inside the room allocated
 - k. Foundation and installation details
 - l. Manufacturer Design Verification documentation
 - m. Verification of temperature rise & thermal stability using calculations as per EN/IEC 61439-1&2.
 - n. Main and Sub-main distribution boards drawn to scale in the electrical/technical rooms.
 - o. Available working clearances around the Main Distribution Boards.
 - p. Utility company's metering provisions with indication of approval by utility company.
 - q. Features, characteristics, ratings, and factory settings of individual over current protective devices and auxiliary components.
 - r. Other needed data if any
7. Coordination Study: Submit coordination study along with setting of protective devices for overload, short-circuit and earth-fault currents as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short-circuit currents at various points.
8. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.

9. Provide complete copies of certificates (including drawings) for rating and short circuit withstand strength for the incoming bus-bars, outgoing bus-bars and main horizontal bus-bars. The certificates must include the actual configuration of the bus-bars proposed for the project.

B. Quality Control Submittals:

Test Reports: submit complete certified manufacturer's type and routine test records, in accordance with the Standards and as follows:

1. Design Verifications required from Original Manufacturer who is responsible for the original design and associated checking that the assembly is conform to the standard IEC61439-1 & 2.
2. To be compliant with standard IEC 61439-1&2 the Original Manufacturer must carry out the original design and the design verifications that have to be certified through an independent certification body such as ASEFA, or by an ASTA, KEMA or LOVAG accredited laboratory, for the most critical configurations:
 - a. Strength of materials and parts (10.2)
 - b. Degree of protection of ASSEMBLIES (10.3)
 - c. Clearances and creepage distances (10.4)
 - d. Protection against electric shock and integrity of protective circuits (10.5)
 - e. Incorporation of switching devices and components (10.6)
 - f. Internal electrical circuits and connections (10.7)
 - g. Terminals for external conductors (10.8)
 - h. Dielectric properties (10.9)
 - i. Verification of temperature rise (10.10)
 - j. Short-circuit withstand strength (10.11)
 - k. Electromagnetic compatibility (EMC) (10.12)
 - l. Mechanical operation (10.13)
3. Routine Tests required from The Assembly Manufacturer (The Panel-Builder) who is responsible for assembly, wiring and the finished assembly. The Assembly Manufacturer (panel builder) has to achieve routine verifications.
Hereafter details of the routine verifications to be performed by the Assembly Manufacturer:
 - a. Degree of protection of enclosures (11.2)
 - b. Clearances and creepage distances (11.3)
 - c. Protection against electric shock and integrity of protective circuits (11.4)
 - d. Incorporation of built-in components (11.5)
 - e. Internal electrical circuits and connections (11.6)
 - f. Terminals for external conductors (11.7)
 - g. Mechanical operation (11.8)
 - h. Dielectric properties (11.9)
 - i. Wiring, operational performance and function (11.10)

In order to guarantee the quality of the delivered assembly, the Panel Builder of this batch will obligatorily provide the certificates or compliance certificates of the Type tests of the manufacturer as well as a copy of the routine test certificates.

- C. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Division 26, Section General Information and Requirements, and additional requirements specified herein.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Original Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 15 years.
 - 1. The Panel Builder shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
 - 2. The Panel Builder or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis:
 - 3. The original manufacturer shall have the ISO 14001 Environment Certification.
 - 4. Subject to compliance with the specifications, obtain the whole board equipment such as Enclosures, Components, Bus-bars and other accessories from one single manufacturer.
- B. The Assembly Manufacturer (The Panel-builder) of this equipment shall have produced similar electrical equipment for a minimum period of seven (7) years and shall be able to submit an up-to-date assembly certification as per IEC 61439-1 & 2 from the original panel board manufacturer that shall be at least 5 years old. When requested by the engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this EN/IEC 61439.
- C. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing switchboards similar in type and scope to that required for this Project.
- D. Contractor shall include imperatively in his price one (1) factory visit, by two Engineers from Engineer's / Client's side in order to attend the switchboard testing – Factory visit. Price shall include business class tickets, five-star hotel accommodation and transportation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
- B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

- C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.
- D. Deliver in shipping splits of lengths not exceeding 2 meters each split and that can be moved past obstructions in delivery path as indicated.

1.8 WARRANTY

- A. General: Warranty shall be provided by the equipment manufacturer and supported by their respective field services organization, for a period of 2 years from issuing the Taking Over certificate to the Contractor or handing over the project to the Operator.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: from 0°C up to 40 °C.
 - 2. Maximum ambient temperature in plant room: 35 °C.
 - 3. Altitude: up to 1000m above sea level
 - 4. Relative Humidity: 0% up to 90% non-condensing
- B. Calculation sheets shall be provided indicating the final temperature reached within enclosure taking into account all heat dissipation sources and ambient temperature.
- C. All necessary natural ventilation to be integrated within enclosure to avoid any de-rating of breakers and busses, otherwise larger rating of breakers shall be used without extra cost.
- D. Coordinate layout and installation of switchgear and components with other construction including conduits, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- E. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- F. Generally: if applicable, coordinate with Building Management System (BMS) supplier and provide all necessary interfaces, relays, transducers, etc., necessary for the functions specified in the BMS schedules.

1.10 SPECIAL TOOLS AND SPARE PARTS

- A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:
 - 1. Contact information for the closest parts stocking location to the Owner.
 - 2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.
 - 3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

- B. Spare parts shall be provided for each type and size of unit installed. At a minimum, the following shall be provided:
 - 1. The minimum spare parts recommended by the manufacturer.
 - 2. One operating motor and/or coil for each type of electrically operated circuit breaker.
 - 3. Two sets of each type of power and control fuse installed within equipment, indicating pilot lights, LED, control switches, and similar devices subject to failure or damage at any time.
- C. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.
- D. Tools and Instruments: Provide tools and instruments required for normal routine inspection and maintenance and testing of circuit breakers and protective devices as appropriate for the type of switchgear supplied.
- E. Removing Circuit Breakers: Suitable arrangements and equipment shall be provided for extracting, lifting and unloading switchgear from enclosures as appropriate for type of switchgear.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers shall be from Europe and all switchboards shall be assembled and FAT tested at the manufacturer's factory in the Europe.

2.2 GENERAL REQUIREMENTS

- A. The totalizing switchboard of the paralleled generators shall be totally compartmentalized and manufactured to Form 3a rating as per EN/IEC 61439-1&2. Each device being mounted on a dedicated mounting plate and housed in its own 'zone'. The devices zone has to be accessible in one operation and should facilitate the current maintenance with infra-red measurement
- B. The switchboard shall be suitable for operating on 3Phase, 4Wires, $U_e=690V$ class of service switchboards, rated insulation voltage of main bus-bars= $1000V$, 60 Hz supply. The IP will be 31 for switchboards installed in dry area and 54 for switchboard installed in wet area to EN/IEC 60529. Shock protection will be IK 10 according to IEC 62262.
- C. The symmetrical fault rating shall be minimum 40KA for 2 seconds for 1500 KVA transformers or 25 KA for 2 Seconds for 1000 KVA transformers. A short circuit study shall be submitted by the contractor taking into account short circuit contribution of motors and the connection of any current source "renewable energy", the short circuit RMS value shall be adjusted accordingly.
- D. The switchboard shall be compartmentalized with individual columns for all frames sizes equal to or larger than 800A and manufactured to IEC 61439-1&2.
- E. All breakers shall be Molded Case Circuit Breaker (MCCB) type, fixed, motorized, 3- poles, with the following features:
 - 1. ICU equal to the prospective short circuit current.
 - 2. ICS = 75% ICU.
 - 3. 2 auxiliary contacts - ON/OFF signaling status

4. 2 Alarm auxiliary contacts
 5. Breakers rated 400A and 630A will be equipped with trip units (LT, ST, INST) as described under “Circuit breakers”.
 6. Breakers rated 250A and below will have Thermo-Magnetic trip units as described in the sections of the “Molded Case Circuit Breakers”.
- F. Energy meter (EM) shall be provided on outgoing energy meters, wherever required by the client.
- G. The arrangement of the equipment within the assemblies shall be individually mounting type in a modular arrangement and shall be such as to afford maximum accessibility to all parts, incoming and outgoing wires and cables.
- H. Surge arrestors protection shall be provided at incoming feeder entry point and shall be coordinated with surge arrestors protection located downstream at entry point of feeder of panel fed directly from main switchboard.
- I. Approved nameplates, permanently mounted for identification of all major and control equipment shall be provided as described under “LABELS”.

2.3 CONSTRUCTION

- A. The low voltage switchgear shall be made of identified free standing vertical structures, suitable for installation side to side and back-to-back and designed to be connected cables. The frame, external panels (doors, side & rear panels, tops) shall be made of metal sheet components shall be protected by polymerized polyester epoxy powder coating, gray color or standard manufacturer’s color subject to Engineer’s approval.
- B. Each vertical structure (or section) shall contain the following:
1. A main horizontal bus bar on the top or at the bottom,
 2. A vertical distribution bus bar to feed the different functional units,
 3. The functional units containing ACB, MCCB, MCB,
 4. A compartment for auxiliary components (instruments, measurement, control...),
 5. Devices shall be installed behind protective front plates; only the operating handles will be accessible. Required internal protection (partitions, barriers) shall be available to create form 2 separation to protect against direct contacts with live parts,
 6. Terminal shields are mandatory for installation of MCCBs and switches.
- C. The section construction shall be so designed that sheet steel barriers shall be provided between each vertical sections, breaker compartments, control and power compartments. Each compartment sheet walls shall provide a protection against direct contacts with live parts and guarantee a degree of protection IP2X.
- D. All the accessories such as but not limited to Mounting plates, Internal separations, bus-bars holders, busbars, bolts, doors, sides and rear panels etc. must be imperatively imported from the original manufacturer. Panel-builder to clearly confirm this requirement and to highlight and cross reference all the accessories in the relative catalogue. It will not be allowed to manufacture any part of the panels locally.

- E. In case of Bus Duct flange interconnection, it is the responsibility of the manufacturer of the switchboard to verify those interconnections regardless if the switchboard and the bus duct are from different manufacturers.
- F. Gland plate for current greater than 600A, and for single core cables shall be made of aluminum.
- G. The low voltage switchgear shall be completely factory assembled, wired and tested.
- H. The structure height shall not exceed 2000mm.

2.4 SWITCHBOARD DESIGN REQUIREMENTS

The following design rules have to be implemented

A. Devices installation

1. All the devices must be installed onto dedicated mounting plate designed for one or several switchgears of the same type. The objective of that point is to group protection equipment of the same type, as well as distinguish inside the switchboard the function of each device or group of devices and avoid identification mistakes.
2. These mounting plates will have an independent fixing system affording them to be transformed and moved anywhere in the switchboard and specially to allow easy evolution of the installation.

B. Electrical distribution and architecture

1. For safety reasons and especially if the door is opened during the switchboard working, all busbars have to be covered by barriers as per the required form onto the whole perimeter of the busbars zone.
2. To supply electricity inside the switchboard, the installation of distribution blocks systems, using spring terminal technology (IPxxB compliant) is a must.
3. To simplify the implementation in compliance with the IEC 61439 1&2, the original manufacturer should supply prefabricated connections that are perfectly rated and coordinated to work with the devices.
4. Vertical distribution systems should be designed to allow accessibility for future maintenance of the dropper busbar. Horizontal and Vertical distribution system should be designed to allow connection (with self-breaking nuts) all along the length thanks to a continuous connection track and this without any drilling.
5. For higher readability of distribution, horizontal busbars should be designed with maximum two bars per phase.
6. For future evolution in the switchboard, busbars should allow the possibility to add all outgoing required without any disassembly.

C. Framework and cover panels

1. The whole covering panels must be dismantlable on all surfaces whatever the IP degree.
2. Switchboards associations should be possible in all directions without any impact on the IP level and when upgrading the maintenance of the original performance levels is guaranteed. The switchboard should be easily combined with switchboards already in service.
3. By design the system should ensure electrical continuity of moving parts without additional earthing braids.

4. The switchboard offer must include dedicated components affording the adjunction of one or several enclosures and cubicles on the exploitation site.
5. Evolution of the number of outgoers of switchboard can be done in a functional unit spare place without having to add extra new upstream connection to the main distribution busbar.
6. For demanding service continuity applications, upgrading of switchboard in term of outgoers extensions can be made in service in unequipped reserved spaces.
7. All switchboard(s) columns shall have glazed doors except for bus-bars & cable compartments that will have a solid door. Even though each functional unit is arranged in a separate compartment, a column will have one single glazed door.

2.5 BUSBARS

- A. The various options will all feature main bus bars of constant section on the entire switchboard and composed of rectangular copper bars of which the number will vary according to the nominal current density. The quality of copper will be ETP following EN13601.
- B. Harmful heating effects, electrodynamic effects as well as electromagnetic radiations will be limited by the specific position of the phase and neutral bus bars.
- C. The interconnection of the main bus bars will be done by means of pre-installed sliding fishplates designed to limit the number of fastening points of tightening. The top of the column will be in several sections corresponding to each useful zone (bus bars, passage of cables) to be able to carry out all interventions on the bus bars without being constrained by the power cables.
- D. For maintenance, the extraction and the reintegration of a column in the middle of a switchboard can be done without displacement of the adjacent columns.
- E. Bus bar interconnection will be guaranteed 20 years' maintenance free. No yearly maintenance on the connections will be required
- F. To facilitate the connection and cable access, main bus bar shall be located on the top or bottom of the section and shall enable an easy connection to the bus bar in the adjacent vertical section. The main busbar should be made of copper bars spliced at each column level in order to achieve simplicity and flexibility in transportation, installation and maintenance. Sliding fishplates should be used to make the connection of the copper bars between columns. Main bus bar design shall allow for front or back cables connection, via the top or bottom plates and all these interfacing possibilities should remain available even with no busbar position change. In order to make easy the installation, bars shall not exceed the section width.
- G. Within a section offering a withdrawable solution, the vertical bus bar shall be located so that the withdrawable breakers can be connected directly on it without need of adapters. When the withdrawable unit is completely removed from its place, the power connection shall be covered with shutters.
- H. The bus bars shall be designed for mounting on insulated supports that are sufficient in number to accept the electrodynamic forces resulting from the flow of the peak asymmetric short-circuit current.
- I. Bus bar insulating supports shall withstand fire and excessive heat as per IEC 60695-2-1.

- J. The Neutral Busbar shall have the same rating of phase Busbars and shall be continuous through all sections. Neutral bus is to be insulated and separate from earth bus and connected to it with removable links.
- K. The Earth Bus is to extend to the full length of the board and shall be firmly fixed to each section in accordance with the Regulations and standards. The Earth Bus shall be complete with two main earthing lugs (one at each end), and required number of feeder protective earth connectors.
- L. Bus-bars are to be accommodated in separate horizontal and vertical sections. The electrical link from the main bus-bars to each distribution MCCB or ACB could be by rigid or flexible insulated bus-bars. Any material used to protect the direct access such as Plexiglas, it has to be fire retardant.
- M. Above performance shall be proven with a test certificate busbars.

2.6 MOLDED CASE CIRCUIT BREAKER

- A. This section applies to molded-case circuit breakers (MCCB) from 100A to 630A for AC (50/60Hz) low voltage electrical installation from 230V to 690V. MCCB shall be equipped with a trip unit that offers the appropriate level of performance to fit to the application.
 - 1. The rated ultimate breaking capacity (Icu) of each MCCB shall be equal to at least the value of the short-circuit current at the point of installation on the electric circuit.
 - 2. The MCCB range will offer several levels of Icu and Ics capacity up to 200kA @440V or 100kA@690V to fit to the application.
 - 3. MCCBs frames up to 630 A shall have utilization category A with rated ultimate short circuit breaking capacity (sequence III) to meet the electrical requirements at the switchboard locations.
 - 4. MCCBs shall be designed for both vertical and horizontal mounting, without any adverse effect on electrical performance. It shall be possible to supply power either from the upstream or downstream side (except for voltage > 500V).
 - 5. For a given MCCB rating frame, MCCBs dimensions shall be the same whatever the ultimate breaking capacity.
 - 6. MCCB shall have a rated operational voltage of 800 V and a rated insulation voltage of 800 V (AC 50/60 Hz).
- B. Safety
 - 1. the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries.
 - 2. All poles shall operate simultaneously for circuit breaker opening, closing and tripping.
 - 3. MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.
 - 4. In order to ensure suitability for isolation complying with IEC 60947-2 § 7-27.
 - 5. The operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated, in OFF position, the toggle

or handle shall indicate the isolation position.

6. Isolation shall be provided by a double break on the main circuit.
7. MCCBs shall be able to receive a device for locking in the “isolated” position, with up to 3 padlocks, Ø8 maximum.
8. MCCBs shall be designed to prevent access to live parts when the cover is removed.
9. MCCBs shall be equipped with a “push to trip” button in front to test operation and the opening of the poles.
10. MCCB rating, “push to trip” button, performances and contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.
11. For rating frame higher than 250 A MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption.
12. In electronic trip units, protection functions shall be electronically managed independently of measurement function by a dedicated ASIC.

C. Current limitation, selectivity, durability

1. From 100 A to 630 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to greatly limit let through energy on the installation. For short-circuits, the maximum thermal stress I^2t shall be limited to: 106 A²s for ratings up to 250 A, 5 x106 A²s for ratings between 400 A and 630 A @440V.
2. MCCBs, the current ratings of which are identical with the ratings of their trip units, shall ensure discrimination for any fault current up to at least 35 kA rms, with any downstream circuit-breaker having a current rating less or equal to 0.4 times that of the upstream circuit-breaker @440V.
3. MCCB from 100A with electronic trip unit shall ensure total selectivity with Miniature Circuit breaker up to 40 A @440V.
4. MCCB’s manufacturer shall provide selectivity and coordination tables with other devices such as other MCCB, MCB, switches up to 690V.
5. The electrical durability of MCCBs, as defined by IEC 60947-2 standard, shall be at least equal to 3 times the minimum required by the standard.

D. Auxiliaries and accessories

1. It shall be possible to equip MCCBs with a motor mechanism for electrically controlled operation. An “auto/manual” switch in front shall, when set to the “manual” position, lock out electrical control; when set to “auto”, lock out the manual control; remote indication of “manual” or “auto” mode shall be possible. It shall also be possible to seal the access to the “auto” control. Closing shall take place in less than 80 ms.
2. Following tripping due to electrical faults (overload, short-circuit, earth fault), remote reset shall be inhibited. It shall however be possible if opening was initiated by a voltage release.
3. The operating mechanism shall be of the stored-energy type only.
4. The addition of a motor mechanism or a rotary handle shall in no way affect circuit breaker

characteristics:

- a. Only three stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism.
 - b. Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module.
5. MCCBs shall be designed to enable safe on-site installation of auxiliaries such as voltage releases (shunt and undervoltage releases) and indication switches as follows:
- a. same field installable auxiliary contacts for signaling different functions, as: open/closed position, fault signal, electrical fault (including electrical leakage) signal, all auxiliaries shall be common for the entire range.
 - b. they shall be separated from power circuits.
 - c. all electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks.
 - d. Auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself.
6. The addition of auxiliaries shall not increase the overall dimensions of the circuit breaker.
7. The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings.

E. Trip Units

1. General

- a. MCCBs shall comprise a device, designed to trip the circuit-breaker in the event of high-value short-circuit currents. This device shall be independent of the thermal-magnetic or electronic trip unit. The breaking will be carried out in less than 10 ms for short-circuit currents above 25In.
- b. MCCBs with ratings up to 250 A shall be equipped with trip units in order to ensure the protection against overcharge and short-circuit. The trip units shall be either of:
 - i. thermal-magnetic.
 - ii. electronic.
- c. MCCBs with ratings over 250 A shall be equipped with electronic trip units.
- d. The trip units shall not augment overall circuit breaker volume.
- e. All electronic components shall withstand temperatures up to 105 °C.
- f. Electronic and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings.
- g. Protection settings shall apply to all circuit breaker poles.
- h. It shall be possible to equip MCCBs with an auxiliary contact signaling an electrical fault operated by the trip unit.

2. Thermo-magnetic trip unit from 16 to 250 A

These trip units shall offer:

- a. Adjustable thermal protection from 0.7 to 1.0 times the current rating.
- b. Fixed magnetic protection for current ratings up to 200 A.
- c. Adjustable (from 5 to 10 times the current rating) for current ratings greater than 200 A.
- d. Adjustable (from 9 (or less) to 14 times the current rating for magnetic only motor protection.
- e. It shall be possible to ensure neutral protection. The tripping threshold shall be equal to that of the phases.

3. Electronic trip units from 16A to 630A

MCCB shall be equipped with a trip unit that offers the appropriate level of performance to fit to the application.

- a. It shall be possible to adjust basic protections with a knob without any power supply or when the main is off.
- b. Electronic trip unit shall be fitted with thermal memory.
- c. The following monitoring functions shall be integral parts of electronic trip units:
 - i. 2 LED for load indication, one lights above 90% of I_r , and one lights above 105 % of I_r .
 - ii. a test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.
- d. MCCBs shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator. The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.
- e. It shall be possible to equip MCCBs with auxiliary contact to indicate the cause of tripping (long time, short time, instantaneous, earth fault if requested).
- f. Electronic trip units for standard application These trip units shall offer
 - i. Long time protection (LT).
 - ii. Selectable I_r threshold settings from 36% to 100 % of the trip unit rating (by knobs).
 - iii. Short time protection (ST).
 - iv. Selectable I_{sd} threshold settings from $1.5xI_r$ to $10xI_r$ (by knob).
 - v. Fixed short time delay 40 ms.
 - vi. Instantaneous protection: fixed threshold between 11 and $15xI_n$, depending on the rating.

4. Electronic trip units for advanced protection:

- a. Long time protection (LT):
 - i. Selectable I_r threshold settings from 36% to 100 % of the trip unit rating (by knob).
 - ii. Selectable temporization from $0.5s@6I_r$ to $16s@6I_r$.
- b. Short time protection (ST)
 - i. Selectable I_{sd} threshold settings from $1.5xI_r$ to $10xI_r$ (by knob).
 - ii. Selectable temporization from 0 to 0.4s with option I_{2t} ON or OFF.
- c. Instantaneous protection
 - i. Selectable I_i threshold settings from $1.5I_n$ to 11 or $15xI_n$, depending on the rating.
- d. Fine adjustment shall be possible by keypad.
- e. Four-pole devices shall be equipped for neutral protection with:
 - i. as standard with a 3-position setting: - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value
 - ii. or LT protection for Neutral could be set separately up to $1,6xI_r_{phase}$.
- f. The following additional protections could be offered according to the MCCB application:

- g. Ground fault protection
 - i. It shall be possible to deactivate the ground fault protection.
 - ii. It shall be possible to adjust the ground fault protection down to 16A.
 - h. Motor protection (unbalance, locked rotor, long start, under load).
 - i. Generator protection.
 - j. Measurement.

These trip units shall offer measurement without additional module. Measurements shall be either:

 - i. Currents: Phases, Neutral, average, max, ...
Or
 - ii. Currents, voltage, power, Energy, Total Voltage Harmonic distortion, Total current harmonic distortion.
 - iii. Accuracies of the entire measurement system, including the sensors: shall be
 - Current: Class 1 as per IEC 61557-12
 - Voltage: 0.5 %
 - Power and energy: Class 2 as per IEC 61557-12.
 - iv. Rogowski current transformers shall be used to ensure accurate measurements from low current up to high currents.
 - v. For safety reason, protection functions shall be electronically managed independently of measurement function by a dedicated ASIC.
 - vi. The measurements shall be displayed on the breaker itself.
5. Additional earth leakage protection
- a. It shall be possible (up to 500 V) to assemble earth fault protection molded-case circuit breakers by adding a residual current device (RCD) directly to the circuit breaker case. The resulting device shall:
 - i. comply with appendix B of IEC 60947-2 standard.
 - ii. be immunized against nuisance tripping as per IEC 60255 and IEC 61000-4 standards.
 - iii. be capable of working normally down to -25 °C ambient temperature.
 - iv. operate without an auxiliary power supply, i.e. it shall be capable of operating normally on any 2-phase or 3-phase power network with a voltage between 200 V and 440 V, and of tripping the circuit-breaker even in the event of voltage dips down to 80 V.
 - b. An option shall allow to use RCD for alarming only.
 - c. RCD module shall not exclude some other module or accessories.

2.7 DIGITAL METERING UNITS

- A. Metering unit shall be provided on the incoming and outgoing feeders having the following functions for each phase:
 - 1. Voltage.
 - 2. Current.
 - 3. Frequency.
 - 4. Energy.
 - 5. Total power.
 - 6. Peak power demand.

7. The Energy Metering unit shall be provided by adequate interface link with the BMS system.

2.8 WIRING

- A. Arrangement: Wiring shall be modularly and neatly arranged on master terminal boards with suitable numbering strips and appropriate cartridge type fuses where required.
- B. Connections shall be made at front of terminal board and with no live metal exposed.
- C. Metal cases of instruments, control switches, relays etc. shall be connected, by bare copper conductors not less than 2.5 mm² section, to nearest earthing bar.
- D. Control Wiring: Copper, PVC insulated, 85 deg. C, 600 V grade, and PVC sheathed multi-core cables. Finely stranded copper conductor, silicon rubber insulated cables shall be used in proximity to higher temperature components and as flexible cable.
- E. Ferrules: Wires shall be fitted with numbered ferrules of approved type at each termination.

2.9 LABELS

- A. Each incoming and outgoing circuit on the switchboard shall be clearly identified on the front panel by means of an engraved label bearing black letters on a white background. The labels shall be of plastic engraving laminate with lettering not less than 5mm high and shall be secured to the panel front with instrument headed machine screws. Where rear access is available label shall also be fixed to the rear panels.
- B. Warning labels shall be fitted in all places where the removal of covers or access panels may expose live equipment operating at a pressure exceeding 250V between phases or to earth. Warning labels shall be of plastic engraving laminate with red lettering on a white background, and shall bear the inscription “DANGER – “LIVE PARTS OVER 250 V” in letters not less than 10mm high.
- C. All equipment and apparatus, both inside and outside the switchboard, including instruments, meters, and relays, which is not clearly identified by integral labeling, shall be adequately labeled in the manner described above for front-of-panel circuit labels

2.10 MISCELLANEOUS

- A. Anti-condensation heaters with disconnect switch and pilot lamp shall be provided in the switchboard, controlled by thermostat and/or hygrostat.
- B. Schematic and wiring diagram shall be provided suitably located within each cubicle.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Apply manufacturer's written instructions.

3.2 EXAMINATION

- B. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- D. Installation of switchboards shall be in accordance with manufacturer's written instructions and shall comply fully with the requirements of NEC, IEC, and recognized industry practices.
- E. Supply all material for construction of base in correct location, level and true grade and connect all incoming and outgoing cables, bus-ducts, etc.
- F. Install the switchboards on to bases using appropriate lifting equipment to ensure that no damage occurs. When correctly located, the unit shall be anchored in position and tested before and after connecting the incoming and outgoing cables, but-ducts, etc.
- G. Check ratings of all circuit protection devices and fill out the circuit directory card upon completion of installation work.
- H. The installation area shall provide enough space in order to allow future extension of the switchgear on both sides and the Opening of front and/or rear doors if any,
- I. Depending on cable connection way, the following shall be foreseen: Connection from top shall provide at least 600mm to allow cable connection, and/or Connection from bottom shall provide at least 600mm on either a trench or a false floor.
- J. Extensions to the low-voltage electrical switchboard shall be possible on either side (right or left) of the switchboard.
- K. Install and anchor switchboards level on concrete bases, 4-inch (100-mm) nominal thickness.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- L. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- M. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- N. Install over current protective devices, transient voltage suppression devices, and instrumentation. 1. Set field-adjustable switches and circuit-breaker trip ranges. F. Install spare-fuse cabinet.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in IEC 61439-1 & 2 as appropriate. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, performs an infrared scan of each switchboard Remove front and rear panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments, Equipment, and Reports:
 1. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
 3. Prior to energization of main and sub-main LV power distribution boards / switchboards, following tests shall be carried out:
 - i. Testing of all accessible bolted connections of busbars, devices and terminations to manufacturer's torque specifications.
 - ii. Testing of insulation resistance.
 - iii. Testing of electrical continuity / short circuits of the circuits.
 - iv. Current injection testing of all circuit breakers and protective devices.
 - v. Ratio tests of all current transformers.
 - vi. High voltage /pressure test with all isolators closed and power fuses fitted but having all control circuits disconnected, for one minute with a voltage of 2kV across the following points:
 - a. Phase to phase.
 - b. Phase to neutral.
 - c. Phase to earth.
 - d. Neutral to earth.
 4. Subsequent to wire and cable hook-ups, energize the LV power distribution boards and demonstrate functioning in coordinate with the requirements. Check whether all outgoing are connected as per load schedules. Record changes in the schedule for final as-built, if acceptable to the Engineer.
 5. Approval of tests and test certificates that may be given shall not relieve the Contractor of the obligation to supply the complete equipment in accordance with the requirements of the Specification.

3.5 OPERATING & MAINTENANCE

A. Operating assistance function

1. Electronic trip units with measurement capability shall offer operating assistance function:
 - a. Indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
 - b. trips history.

- c. alarms history.
 - d. events history (setting changes, test...).
- 2. These functions and indicators shall be available on the display, or setting PC tool.
- B. Alarms (Advanced protection trip units)
 - 1. User shall be able to activate alarms based on measurement (I, U, F, Q, Idemand, Pdemand, etc..).
 - 2. Alarms shall be time stamped.
 - 3. Alarms could activate up to 6 relay output(s).
 - 4. These functions and indicators shall be available by display or setting PC tool.
- A. Auto-test – LED “Ready”
 - 1. MCCB’s electronic trip unit shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator, that will not cause the circuit-breaker to trip.
 - 2. The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.
- C. Commissioning and Operating tool
 - 1. A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.
 - 2. A software tool available for all electronic trip unit shall be provided:
 - a. To visualize and configure trip unit parameters.
 - b. To create and save setting files.
 - c. To display tripping curve.
 - d. To set time and date.
 - e. To display tripping and alarms histories

3.6 ADJUSTMENTS

Adjust circuit breakers, protective relays and other control devices to provide adequate over current protection and selective tripping with downstream devices in accordance with short circuit and protection coordination study and after proper coordination with protection settings of Electricity Supply Authority.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning; Repair exposed surfaces to match original finish.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 1 Section "Demonstration and Training."

3.9 ACCESSORIES

- A. All the rooms for main switchboards shall be equipped with all accessories necessary to form a complete installation including, but not be limited to, the following operating and safety accessories:
1. 1 pair of insulating gloves.
 2. 1 rubber mat 10 mm thick x 1000mm wide and extending the full length of the equipment.
 3. 1 notice and safety instruction chart including first aid chart for electric shock.
 4. Any other equipment necessary to comply with the standards.

END OF SECTION